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Federal Communications Commission
Office of Secretary

November 22, 1996

EX PARTE

Mr. William Caton
Acting Secretary
Federal Communications Commission
1919 M Street, N.W. 20554

Re: CC Docket 95-116, Telephone Number Portability

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Please include this correspondence as part of the public record in the above-captioned proceeding.

Sincerely,

Marie Breslin

Attachment

cc: M. Littell

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Date: July 11, 1990

Subject: Effects of Initial and Subsequent AIN Call Setup Delays on Grade of Service Expectations

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TECHNICAL MEMORANDUM TM- NWT-016605

1. EXECUTIVE SUMMARY

The implementation of the Advanced Intelligent Netwrok (AIN) will introduce additional call setup times for customers encountering AIN-related services. For many services this additional time will simply be idle time, which will be perceived by customers as an increase in POTS call setup time. It is desirable that the additional setup time experienced by these customers be held to a minimum to avoid degradation of customer opinion. It has been proposed that the performance objective for this additional time be a maximum of 1.5 seconds. To evaluate the effect of this additional time on customer opinion, the effects of additional call setup times of 1.0, 1.5, and 2.0 seconds were evaluated using three call setup time models.

In general, the analysis shows that the reduction in grade of service (% Good or Better) ratings may show wide variability depending on the currently observed POTS (plain old telephone service) call setup times and the model chosen. The estimates on the reduction in grade of service are based on the assumptions that initial extra delays will be in the range of 1.0 to 2.0 seconds.

It is concluded that additional studies must be conducted to resolve differences in the three models predictions of the effect of additional AIN call setup time on POTS customer opinion. The results of these studies will produce a reliable model of opinion and allow the offering of AIN services with CST performance acceptable to our customers, and can be used to determine recommended performance objectives so that AIN services do not introduce excessive call setup delays as happened with 800 Data Base Service, and to support the BCCs in call setup time regulatory proceedings.

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2. INTRODUCTION

Advanced Intelligent Network (AIN) is a service independent architecture which can quickly and economically introduce new telecommunication services. AIN is based on distributed call processing, and as a result some calls may experience increased call setup time (CST) delay due to extra signalling and processing. For example, suppose Albert wants to place a plain-old telephone service (POTS) call to his friend Benjamin. Benjamin, the terminating party, is a subscriber of an AIN feature called terminating call screening. This feature allows Benjamin to screen all incoming calls to his line. As a result of this screening function, Benjamin's friend may think that his POTS call is taking longer to setup than usual (because his call is now being screened for acceptance or rejection). As we can see, AIN services can introduce extra delays that a typical caller may not expect, due to special processing associated with the AIN architecture.

This paper focuses on the effect of this type of initial CST delay on originating POTS customers. Notice that an originating call requiring AIN intervention (for example, 976 screening with terminating call screening) may experience even longer CST delays due to processing both at the originating and the terminating end of the call.

Any *new* CST delay can affect existing grade of service (GOS) quality as expressed by customer opinion models. Grade of service quality refers to the percentage of users who would judge the quality of a call to be good or better (%GoB, good or excellent responses) or poor or worse (%PoW, poor or unsatisfactory responses) based on one or more criteria. It is well known that grade of service provides a meaningful way to describe customer satisfaction with a service.

The objective of this paper is to present the estimated reductions on GOS ratings that may result when additional delays are introduced on POTS calls. In reference [1], a preliminary AIN CST objective of 1.5 seconds above POTS is proposed as a guideline for allocating the response times of AIN network elements such as SSP, Adjunct, and SCP. Therefore, this paper focuses on additional delays of 1.0, 1.5, or 2.0 seconds above POTS.

These estimated reductions on GOS ratings can be used to help service designers to assess the performance impact that the initial AIN-added delay (of 1.0, 1.5, or 2.0 seconds) will have on customer acceptability. These estimates are based on previous POTS Grade of Service data as described below.

3. PREVIOUS WORK

We have chosen to study all three major opinion models that exist today. Since each was derived from data collected under different settings it is possible to compare the estimates across the models to give us some feeling on the opinion rating bounds. Below are some backgrounds on the models.

3.1 KORT MODEL

Kort [3] setup a laboratory study in which people played a game that required them to place a series of calls to an experimenter. For each call, CST and other switching and transmission parameters were manipulated[1]. At the conclusion of the call, subjects rated connection quality using a five-point category rating scale, *unsatisfactory, poor, fair, good*, and *excellent*. After an extensive analysis of the data, the results of this experiment were used to develop a call completion opinion model [6]. This allowed a model to be generated which specified the relationship between call setup time (CST) and user opinion. However, the generality of this model may be limited because it is based on data collected more than fifteen years ago. Customer expectations of acceptable network performance may have changed since then. Another concern is that, as in any laboratory study, the validity of the model is dependent on the extent that the subjects behaved in a laboratory environment as they would under more natural circumstances. Figure 1 shows the GOS curves for all three models.

3.2 SYBIL MODEL

This second model combines some of the positive attributes of the callback interview and laboratory experiment methodologies [2]. In this study some of the ordinary business calls made by volunteer Bell Telephone Laboratory (BTL) employees were routed through a laboratory facility where CST and other switching and transmission parameters were manipulated. At the end of each completed call, the caller received a ringback signal which indicated that he/she should rate the service quality of the call on a five-point category rating scale, *unsatisfactory, poor, fair, good*, and *excellent*. The data obtained in this test were later used to develop a model of the effect of switching and transmission impairments on user opinion [4,6]. The generality of this model is limited because it is based on data collected more than a decade ago, and in the study CST was manipulated only for intra-building calls. It would be desirable to conduct a similar study where the CST of Intra- and Inter-LATA calls is varied. However, the laboratory facility described above is no longer available.

3.3 AIN-SCT MODEL

A study was conducted in 1989 by the authors [5] to characterize customer satisfaction with the number and duration of network interactions that may exist for AIN calls. To achieve this, a series of Network Automatic Call Distribution (N-ACD) type calls were simulated in the laboratory and subjects were asked to rate the overall call setup performance. The ratings, on the same five-point scale as above, were used to compute the Mean Opinion Scores and the Fit Means, which in turn were used to arrive at a preliminary Service Completion Time[2] (SCT) Opinion Model.

The result of the study showed that opinion varied as an exponential function of total service completion time and whether or not interactions were involved.

While this study provided a good amount of insight into how the two variables (number and duration) interact in determining subjective opinion, the results are still preliminary and

1. The Kort and Sibyl models include other switching and transmission performance parameters. For these models a value of .1 seconds was assumed for dial-tone delay, and a R_{LN} of 90 used. The plot for the Kort Model is based on a conversation time of 10 seconds.

2. In [5], a distinction is made between CST and SCT. When interactions between the caller and the network is necessary to complete an AIN call, then SCT is used, which may include network announcement time, among other components of SCT. When no network interactions are presented in an AIN call, SCT is analogous to CST.

further experiments should be conducted to validate the observations and proposed models.

Generally, the grade of service in the AIN-SCT study falls between the values predicted by the two other CST opinion models. Possibly, the AIN-SCT Model might be the most valid of the three opinion models, since there is some reason to believe that the Kort Model underestimates the effect of CST on opinion, and the Sibyl Model overestimates the effect of CST. Whether or not this is the case must await the results of additional subjective testing.

3.4 LIMITATIONS OF PREVIOUS WORK

There are some limitations with the use of past opinion models to predict the impact of extra CST delays on AIN calls. In the past, the majority of the POTS calls were set up using Multi-Frequency (MF) signaling. The three opinion models, described above, were based on opinions provided by people whose expectations of acceptable CST performance were influenced by a public network that used MF signaling. In today's environment, more and more calls are being setup using out of bound signaling, i.e., the Signaling System 7 (SS7) network. As a result, customer's expectations of CST may be changing. These new expectations may cause customer opinion ratings to change. Thus, additional studies to gather new customer opinion data may be necessary.

4. AIN IMPACT ON GRADE OF SERVICE

The models derived from the above three studies were used to predict the impact (i.e., reduction) that additional CST may have on the *percent good or better* (%GoB). In Figure 2, we plot the reduction in %GoB resulting from an additional 1.0 second CST (due to AIN processing). The three curves correspond to the three models. The significant shape differential among the models are caused by the method in which the data was collected for each model. The area within the outer curves can be interpreted as the "significant region" where the true (or best estimates of the) degradation on the %GoB lies.

In Figure 3 and 4, we plot the reduction in %GoB caused by additional delay of 1.5 and 2.0 seconds over the current POTS CST. For example, in Figure 3, if we assume that an additional AIN CST of 1.5 seconds were added to a current POTS CST of 4 seconds, then the Sybil model predicts an approximate 10% reduction %GoB ratings, the AIN-SCT Model predicts an approximate 5% reduction and the Kort Model predicts an approximate 2.5% reduction in Good or Better ratings. Similar observations can be derived from Figures 2 and 4.

Observe that the Kort Model is almost flat which indicates that the approximate (2-3 percent) reduction is almost constant regardless of the current CST delay.

Also notice that the Sybil Model has a negative slope which implies that as the current CST delay is larger, the percent reduction is smaller. The AIN-SCT model predicts the opposite result. One explanation for the divergent predictions may be due to different user expectations about normative call setup times (i.e., intra-building vs. POTS calls). Therefore, we must be careful with the interpretation of the results presented here, as will as discussed below.

5. SUMMARY/CONCLUSION

Three opinion models (Kort, Sybil, and AIN-SCT) were used to predict the impact that may result when extra delays due to AIN processing are introduced on most future calls.

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In general, the analysis shows that the reduction in grade of service (% Good or Excellent) ratings may show wide variability depending on the currently observed POTS (plain old telephone service) call setup times and the model chosen. The estimates on the reduction in %GoB are based on the assumptions that initial extra delays will be in the range of 1.0 to 2.0 seconds.

It is recommended that additional studies must be conducted to resolve differences in the three models predictions of the effect of additional AIN call setup time on POTS customer opinion. The results of these studies will allow the offering of AIN services with CST performance acceptable to our customers, and can be used to determine recommended performance objectives so that AIN services do not introduce excessive call setup delays as happened with 800 Data Base Service, and to support the BCCs in call setup time regulatory proceedings.

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6. REFERENCES

[1] A. Atai, "Performance Modeling of AIN Architecture," Technical Memorandum. TM-NPL-015904, January 10, 1990.

[2] H. S. Cohen, "Preliminary Proposals for Study of Switching and Transmission Grade of Service with SIBYL," Engineer's Notes, case 49428-445, file 40004-1 36750-1, November 7, 1979.

[3] H. S. Cohen and B. W. Kort, "Psychological Evaluation of Telephone Switching and Transmission Performance," *Proceedings of the Human Factors Society 21st Annual Meeting*, San Francisco, October 17, 1977, 505-507.

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[5] B. Cotton and K.K. Kuong-Lau, "Caller Acceptability of Network Interactions for AIN Services," Technical Memorandum, TM-BSD-015868, December 22, 1989.

[6] B. W. Kort, "Models and Methods for Evaluating Customer Acceptance of Telephone Connections," *GLOBECOM '83 Conference Record*, Vol. 2 (November 28 to December 1).

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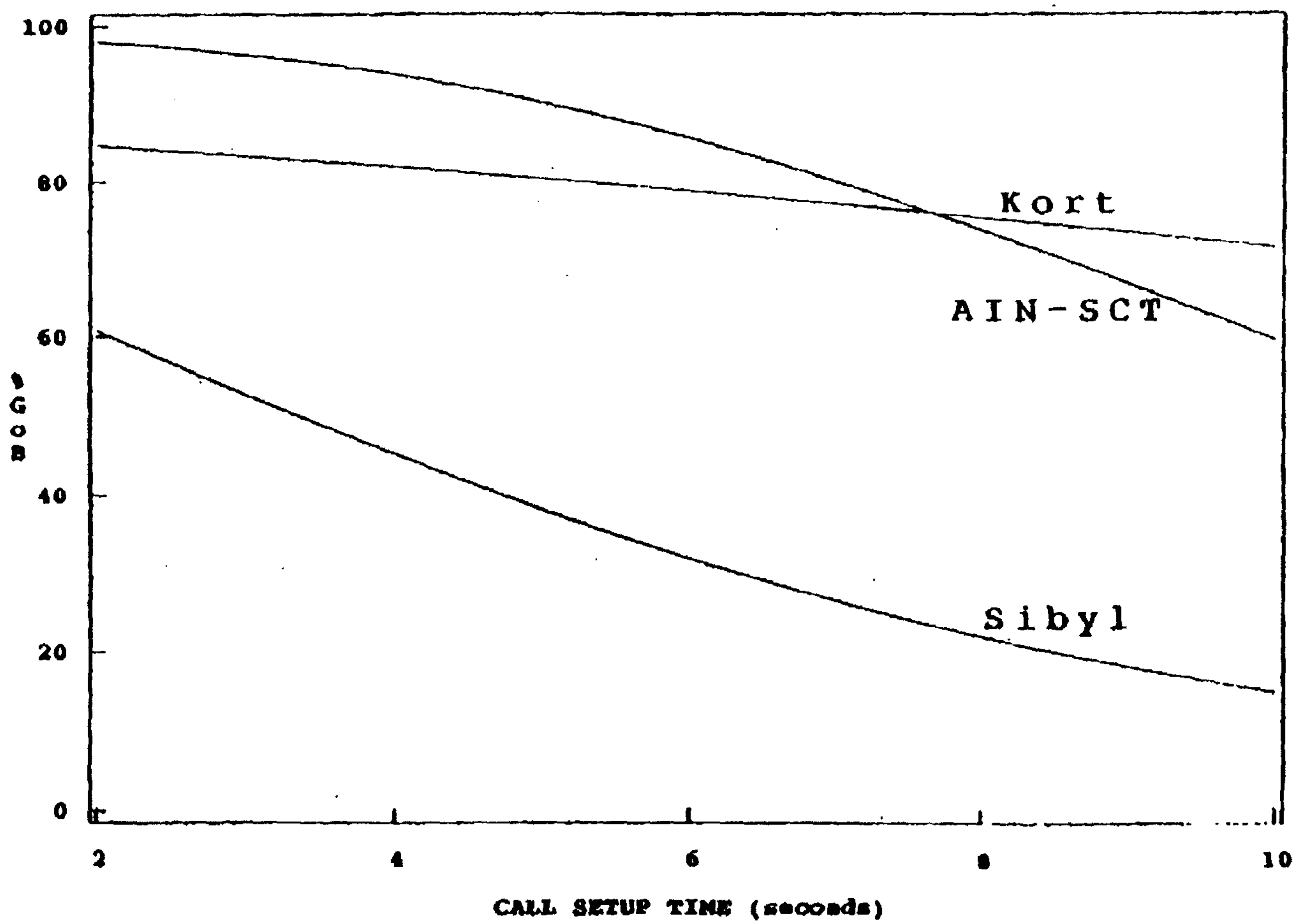

Figure 1. A comparison of the percentage of good or better (%GoB) responses predicted by the Kort, Sibyl, and Cotton call setup time models developed for POTS services.

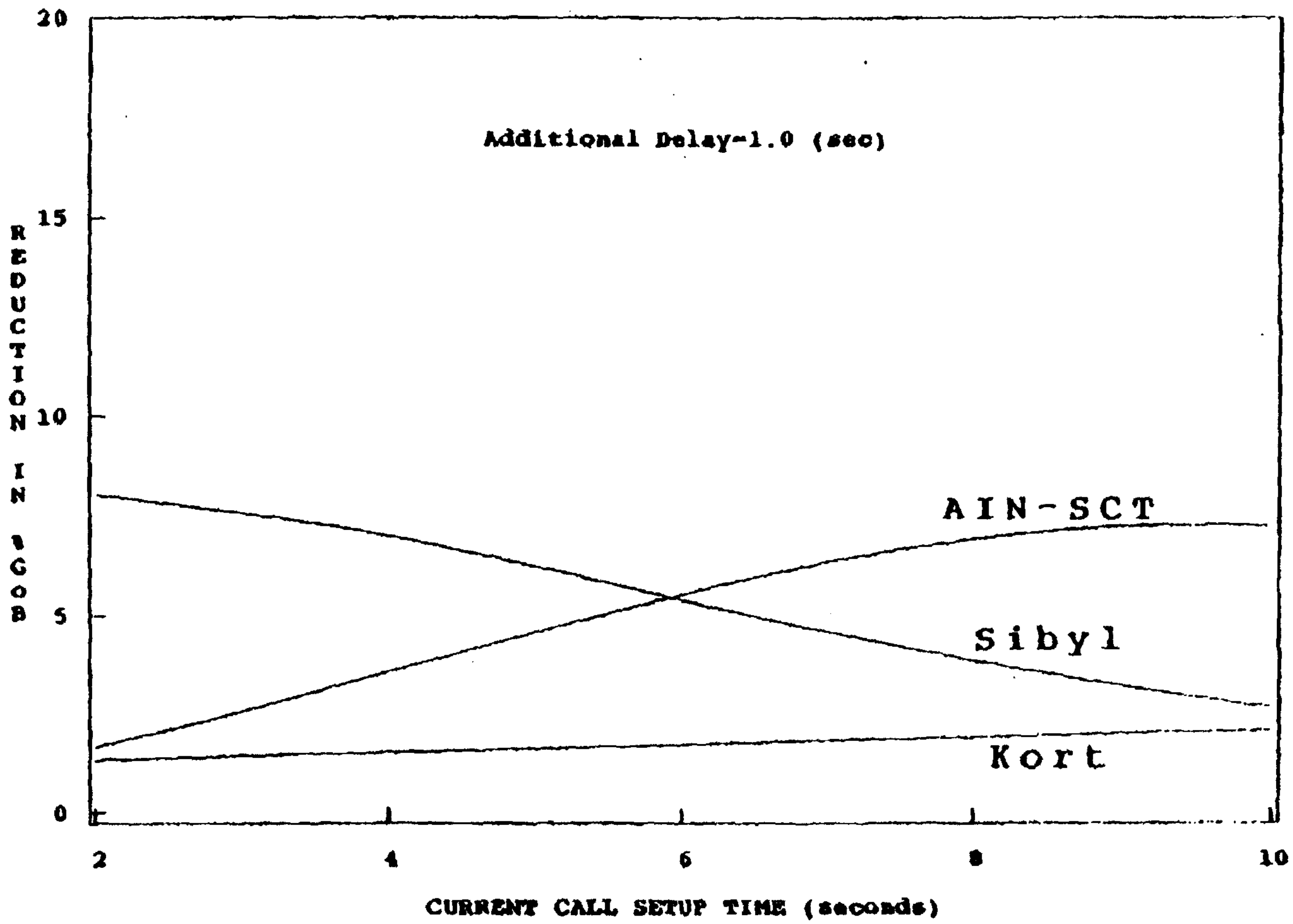

Figure 2. Reduction in percentage of good or better (%GoB) responses predicted by three models if the current call setup time is increased by 1.0 seconds.

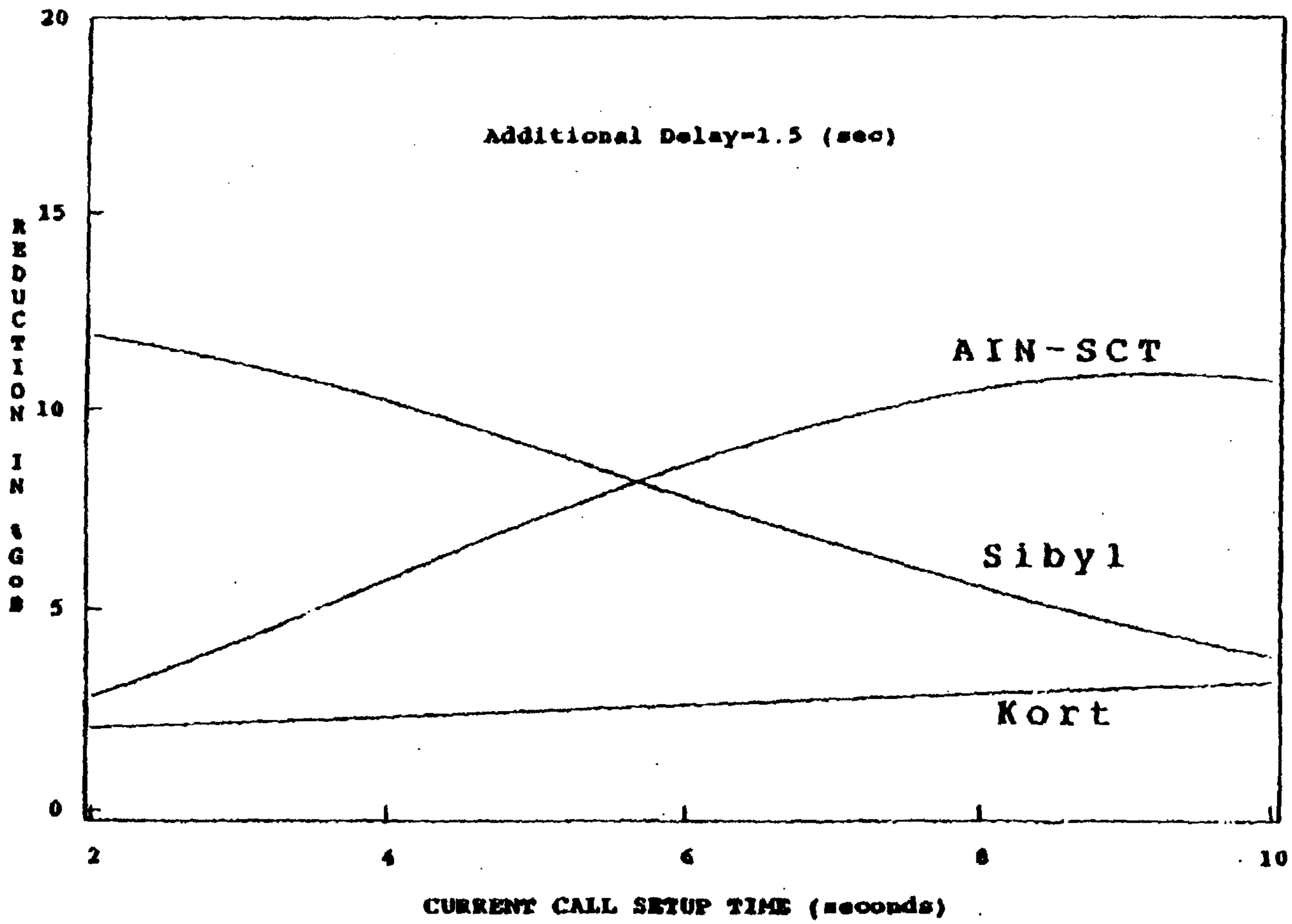

Figure 3. Reduction in percentage of good or better (%GoB) responses predicted by three models if the current call setup time is increased by 1.5 seconds.

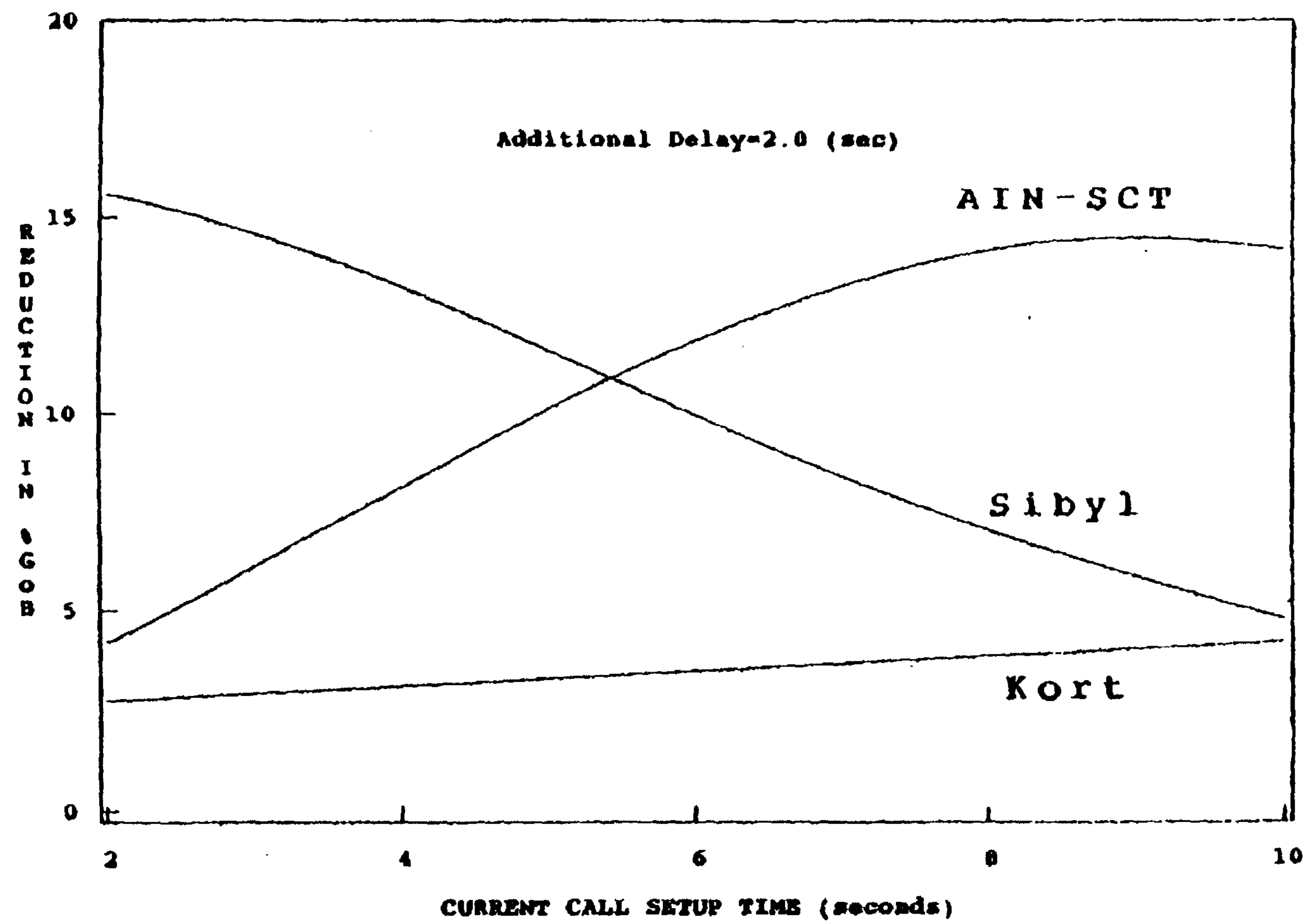

Figure 4. Reduction in percentage of good or better (%GoB) responses predicted by three models if the current call setup time is increased by 2.0 seconds.